

## WHAT IS CLAIMED IS:

1. A thermal barrier coating for an underlying metal substrate, which comprises:
  - a. a porous outer layer having an exposed surface and comprising a non-alumina ceramic thermal barrier coating material in an amount up to 100%; and
  - b. alumina infiltrated within the outer layer in an amount sufficient to protect the thermal barrier coating at least partially against environmental contaminants that become deposited on the exposed surface.
2. The coating of claim 1 which has a thickness of from about 1 to about 100 mils and wherein the outer layer comprises from about 95 to 100% of the thickness of the coating.
3. The coating of claim 2 wherein the outer layer comprises from about 98 to 100% of the thickness of the coating.
4. The coating of claim 2 wherein the outer layer comprises from about 95 to 100% of a zirconia.
5. The coating of claim 4 wherein the outer layer comprises from about 98 to 100% of a yttria-stabilized zirconia.
6. The coating of claim 2 wherein the infiltrated alumina is finely divided alpha alumina.
7. A thermally protected article, which comprises:
  1. a metal substrate; and
  2. a thermal barrier coating comprising:
    - a. a porous outer layer overlaying the metal substrate, the outer layer having an exposed surface and comprising a non-alumina

- ceramic thermal barrier coating material; and
  - b. alumina infiltrated within the outer layer in an amount sufficient to protect the thermal barrier coating at least partially against environmental contaminants that become deposited on the exposed surface.
- 8. The article of claim 7 which further comprises a bond coat layer adjacent to and overlaying the metal substrate and wherein the outer layer is adjacent to and overlies the bond coat layer.
- 9. The article of claim 8 wherein the thermal barrier coating has a thickness of from about 1 to about 100 mils and wherein the outer layer comprises from about 95 to 100 % of the thickness of the thermal barrier coating.
- 10. The article of claim 9 wherein the outer layer comprises from about 98 to 100 % of the thickness of the thermal barrier coating.
- 11. The article of claim 9 wherein the outer layer comprises from about 95 to 100% of a zirconia.
- 12. The coating of claim 11 wherein the outer layer comprises from about 98 to 100% of a yttria-stabilized zirconia.
- 13. The article of claim 9 wherein the infiltrated alumina is finely divided alpha alumina.
- 14. The article of claim 9 which is a turbine engine component.
- 15. The component of claim 14 which is a turbine shroud and wherein the thermal barrier coating has a thickness of from about 30 to about 70 mils.
- 16. The shroud of claim 15 wherein the thermal barrier coating has a thickness of

from about 40 to about 60 mils.

17. A method for preparing a thermal barrier coating protected by infiltrated alumina that overlies a metal substrate, the method comprising the steps of:

1. providing a thermal barrier coating overlaying a metal substrate, the thermal barrier coating including a porous outer layer having an exposed surface and comprising a non-alumina ceramic thermal barrier coating material in an amount up to 100%;
2. treating the outer layer with a liquid composition comprising an alumina precursor to infiltrate the outer layer with the alumina precursor in an amount sufficient to provide, when converted to alumina, at least partial protection of the thermal barrier coating against environmental contaminants that become deposited on the exposed surface; and
3. converting the infiltrated alumina precursor within the outer layer to alumina.

18. The method of claim 17 wherein a bond coat layer is adjacent to and overlies the metal substrate of step (1) and wherein the outer layer is formed on the bond coat layer.

19. The method of claim 18 wherein the liquid composition comprises from about 5 to about 50% alumina precursor.

20. The method of claim 19 wherein the liquid composition comprises from about 10 to about 20% alumina precursor.

21. The method of claim 19 wherein the alumina precursor is selected from the group consisting of aluminum alkoxides, aluminum  $\beta$ -diketonates, aluminum alkyls and alumina sols.

22. The method of claim 21 wherein the alumina precursor is an aluminum

alkoxide selected from the group consisting of aluminum methoxides, aluminum ethoxides, aluminum propoxides, aluminum isopropoxides, aluminum butoxides, aluminum sec-butoxides and mixtures thereof.

23. The method of claim 22 wherein step (3) comprises thermally converting the infiltrated aluminum alkoxide to alumina.

24. The method of claim 23 wherein step (3) comprises heating the infiltrated aluminum alkoxide to a temperature of at least about 1200°F for a period of at least about 2 hours.

25. The method of claim 24 wherein step (3) comprises heating the infiltrated aluminum alkoxide to a temperature of from about 1200° to about 1500°F for a period of at least about 4 hours.

26. The method of claim 23 wherein the infiltrated aluminum alkoxide is thermally converted to finely divided alpha alumina.

27. The method of claim 22 wherein the liquid composition is an aqueous composition.

28. The method of claim 27 wherein the liquid composition further comprises a polar organic liquid solvent selected from the group consisting of alcohols, aldehydes, ketones and mixtures thereof.

29. The method of claim 19 wherein the outer layer is treated with the liquid composition for a period of from about 0.1 to about 30 minutes.

30. The method of claim 29 wherein the outer layer is treated with the liquid composition for a period of from about 1 to about 5 minutes.

31. The method of claim 17 wherein the thermal barrier coating of step (1)

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overlies a metal substrate of a turbine component and wherein the outer layer is treated with the liquid composition during step (2) while the turbine component is in an assembled state.